Water Hyacinth Biological Control
Status of Weevils in the Sacramento/San Joaquin Delta

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In the early 1980's, two weevil species, *Neochetina eichhorniae* and *N. bruchi*, were released in the Sacramento/San Joaquin Delta for the control of water hyacinth. Over a two-to-three year period, approximately 3,000 *N. bruchi* were released at three sites, and 7,500 *N. eichhorniae* at two sites (one site received both). Follow-up studies indicated that *N. eichhorniae* had taken up residence in the Delta, while the fate of *N. bruchi* appeared more uncertain. Long-term monitoring had not been completed.

The State Legislature requires the California Department of Boating and Waterways (CDBW) to control water hyacinth in the Delta. Historically, this control depended upon herbicides, but recent public and regulatory concerns have prompted the CDBW to explore alternative options. Biological control may prove useful in waterways within the Delta that are more or less isolated from the general channel system. The CDBW is limited in treating many of these areas yet hyacinth populations are extremely dense.

During 2002, we investigated options to obtain weevils and move them into dense isolated patches of water hyacinth. One possible source for weevils is to field collect them from areas where the populations are high, such as in Florida. While this is economical, an average of four to nine percent of weevils in the southeast have a chronic protozoan infection, known as microsporidian disease. The disease decreases lifespan and, especially, egg production. Infection rates can become much higher if the population is stressed or crowded. While keeping the disease out of California is desirable, producing disease-free weevils is expensive. Therefore, we established a field survey of the Delta to determine if weevils were still present and if they were already infected.

The primary goal of the survey was to collect 200 to 300 weevils to screen for microsporidia disease. These numbers were determined by considering the likely infection rates and the probability of falsely concluding there was no microsporidian disease in the Delta. For example, *N. bruchi* has an average infection rate of about four percent in the Southeast. If a conservative assumption was made that the true infection rate was as low as one percent, there would be a probability of 0.134 (or about one in eight) of collecting 200 weevils without microsporidia, and thereby falsely concluding there was no disease. If 300 weevils were screened, the probability decreases to 0.049, or about one in 20.

The survey covered a two-week period, September 24 to October 3, 2002. All collections were made from an airboat or a conventional boat. At each collection site plants were examined for adult weevils, which is the easiest life-stage to find. During the first portion of the survey, weevil collections were combined for microsporidia screening. It was soon determined that weevils were much more common in the Delta than previously suspected. Therefore, during a second set of more extensive site visits, care was taken to note the number of weevils collected at each location, and to keep these different collections separated. For this second portion of the survey, the crew visited 23 locations (Map 1). Twenty to 50 plants were searched at each location, depending on the amount of damage and the rate at which weevils were recovered. The intent was to recover no more than 75 weevils from any one site. Fewer plants (generally 20) were searched at sites where there was very little damage or the rate of finding weevil was low. Fewer plants were also searched at sites where many (five to 15) weevils were recovered from each plant, as the limit of 75 was quickly reached.

In selecting survey sites, an attempt was made to cover the navigable Delta east to west and north to south. A site was selected if it had at least a few patches of hyacinth and was several miles from previous sites. The selection of search sites was relatively unbiased in that a patch was not usually scanned for damage before landing the boat and searching at least 20 plants. The survey therefore should reasonably represent the relative weevil distribution. Within a site, plants with heavier weevil damage were selected for searching, so the density of weevils per plant may be overestimated. (Map 1) shows the number of weevils normalized to a basis of 100 plants searched, for comparison.

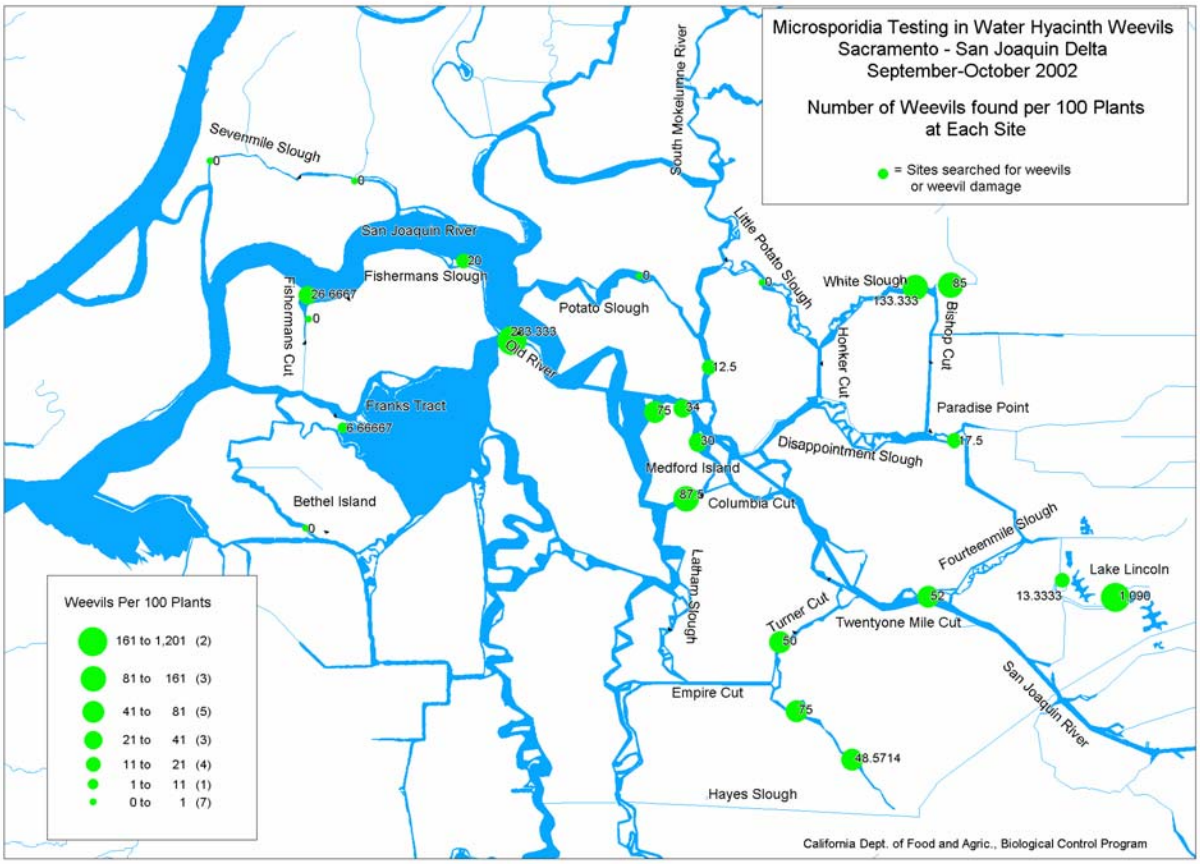
All collected weevils were identified to species. Preliminary identifications suggested *N. eichhorniae* might be uncommon in the collections, yet it was originally the more abundant species. Therefore, special care was taken in the identifications. Specimens were compared to keys, descriptions, and voucher specimens. An insect systematist who had worked with the two weevils was also consulted. A total of 322 weevils were submitted for microsporidia screening to Mr. Bud Thomas, Consulting Diagnostic Service, Berkeley.

The four preliminary collections yielded 143 weevils, and the main survey yielded an additional 354 weevils. The survey showed that weevils are common in much of the Delta and can be relatively abundant in some locations. We found weevils at 17 of 23 sites, where the range ran from two to 109 weevils. Between 10 and 20 weevils were recovered from nine sites, between 30 and 40 weevils were recovered at two sites, only one site had more than 40 weevils, and the remaining five sites had less than 10 weevils. The distribution of the weevils in the Delta seemed to be lower in the west and higher towards the east. In part this seemed to parallel the abundance of hyacinth, but hyacinth abundance did not strongly affect the density of the weevils. For example, one of the largest sets of mats found was at Frank's Tract, toward the west of the search area, but only two weevils were found in 30 plants searched. In contrast, for the patch where over 100 weevils were found, field staff had seen only two or three other small patches in miles of traveling the water channel; the patch itself was only about 20 by 30 feet, and it had been treated with herbicide.

The identification of the weevils showed that only *N. bruchi* had been collected, implying that only *N. bruchi* has become established in the Delta. This is surprising, as fewer *N. bruchi* were released in the original introductions, the main release site for *N. bruchi* was destroyed a few years after the introductions, and *N. eichhorniae* is often more abundant in other areas of the United States. On the other hand, *N. bruchi* has a shorter life cycle than *N. eichhorniae,* which might make it more efficient in the highly dynamic conditions of the Delta.

None of the 322 weevils screened for microsporidia were infected. In addition, no signs of other pathogens were visible. If the true infection rate were one percent, there would be a probability of 0.039, or about one in 25, of collecting 322 clean weevils. If the infection rate were about 2.2 per 1,000, there would be a probability of about 50 percent of collecting 322 clean weevils. In other words, the weevils almost certainly had less than a one percent infection rate, but there is a 50 percent chance they had at 0.2 percent infection rate or less. It appears that the weevils in California are free of disease.

Map 1


Microsporidia Testing in Water Hyacinth Weevils
Sacramento - San Joaquin Delta
September-October 2002
Number of Weevils found per 100 Plants at Each Site
= Sites searched for weevils or weevil damage
Weevils Per 100 Plants
161 to 1,201 (2)
81 to 161 (3)
41 to 81 (5)
21 to 41 (3)
11 to 21 (4)
1 to 11 (1)
0 to 1 (7)
Sevenmile Slough
South Mokelumne River
San Joaquin River
Fishermans Slough
Fishermans Cut
Potato Slough
Old River
Little Potato Slough
White Slough
Bishop Cut
Honker Cut
Franks Tract
Bethel Island
Medford Island
Columbia Cut
Disappointment Slough
Paradise Point
Fourteenmile Slough
Lake Lincoln
Leatham Slough
Turner Cut
Twentyone Mile Cut
Empire Cut
Hayes Slough
San Joaquin River
20
26.6667
0
283.333
12.5
75
34
30
87.5
133.333
85
17.5
52
13.3333
1,090
50
75
48.5714
California Dept. of Food and Agric., Biological Control Program